INTEGRATING MULTIMODAL TRAVEL INFORMATION AT MAJOR TRANSPORT INTERCHANGES: THE PROSPECTIVE OF INTELLIGENT PUBLIC TRANSPORT INFORMATION SYSTEM.

Syahriah BACHOK, Wen Long YUE and Rocco ZITO
Transport Systems Centre, School of Natural and Built Environment
University South Australia
City East Campus, North Terrace, 5000 Adelaide
Australia
Syahriah.Bachok@postgrads.unisa.edu.au

ABSTRACT

Inducing car-drivers to switch mode to public proved to be one of the greatest challenges faced by many transport planners and traffic engineers. Retaining public transport users also seemed to be an issue, especially within an industry that has dwindling patronage trends. This paper presents some findings of an evaluation of a hypothetical rail-bus information integration to promote the retaining of existing users of a public transport service. In the events of service disruptions, users' perceptions of and travel decisions relating feeder bus services were assessed. Messages regarding the availability of the supplementary service were provided to assist users; particularly for interchanges or transfers purposes. The major findings regarding mode and route selections are reported and discussed.

The modal split changes are highlighted and potentials of integrating rail-bus information are outlined. Modelling the switching behaviours has been undertaken utilising a number of statistical software packages. The proportion of prospective passengers selecting feeder buses are calibrated based on parameter estimates derived from the model developed, and further validated against the observed behaviours. Factors such as personal traits, trip characteristics and previous decisional influences on the current selection are discussed in brief.

1. INTRODUCTION

High car ownership and use in many cities have resulted in severe congestion and pollution on the road system. Public transport systems suffer the most, especially buses because road spaces were taken up by private vehicles, thereby increasing the overall travel time and its variability. To relieve road of these inefficient use, many initiatives were taken especially with regard to inducing car-drivers to switch mode to public modes. However, this has proved to be one of the greatest challenges faced by many transport planners and traffic engineers.

Retaining public transport users also seemed to be an uphill task in an industry facing a downward trend of overall patronage. Public transport rides are deemed as inconvenience by many private vehicle users mainly due to the need to transfer between modes and the imperfect and sometimes non-existence information provision. This paper investigates the existing supply of multimodal in a case study in Malaysia. This paper will also present findings of an evaluation of a hypothetical rail-bus information integration to retain existing users of a public transport service.

Based on the survey results, an analysis of responses to multimodal public transport information provided at several interchanges was undertaken. This involved describing the travel patterns and characteristics of users with transfer needs. The study proceeded with an attempt to explain and model mode switching behaviour or modal split decision among the users surveyed. Even though, the analysis using SPSS, MsExcel and LIMDEP programs was impeded by the relatively

insignificant statistical results; the study has found that income and experiences with previously delayed trips have somewhat influenced the decisions regarding mode selection in the events of public transport services disturbance or delays.

2. INFORMATION AND PUBLIC TRANSPORT INTERCHANGES

One important barrier to public transport use is the imperfect pre-trip and en-route information, in particular within public transport interchanges. This acted as a hindrance for many private vehicle users as well as the existing public transport patrons. The common problems were the none-existence or little information available on timetables and unfamiliarity with routes and transfers maps. Depending on the type of uses, and the frequency and regularity of trips, improving the information systems and deliveries would induce some non-users to these modes of transport.

In some services, there existed neither route maps nor directional information. More often than not, information was supplied at the beginning of new public transport operation, but somehow neglected afterwards. Service providers often attributed this to high costs of maintenance and public transport travel time variability. Too frequent a change in timetables that there was no longer a point to do so, which was typical of developing cities public transport system (Wright and Fjellstrom, 2002). This is an unattractive feature of public transport relative to private vehicles, whereby the uncertainty of overall journey time and the assurance that passengers will reach destination by the required arrival time were in the least.

Imperfect information especially regarding waiting time at stops or stations is also a stigma often associated with public transport use. Providing real time and reliable information on public transport scheduled and interruptions of services, traffic conditions as well as the countdown time of the next arrival time of vehicles, seemed to be a challenge for many public transport operators (KTMB, 1996). Providing integrated and coordinated information regarding connecting modes and assuring seamless and continuous transfers proved to be even more difficult. Without this information, it was not an easy task to instill trust and confidence among passengers, let alone inducing car drivers out of their vehicles into riding public transport.

Non-users had expressed anxiety, frustration and ignorance about accessing journey planning information (Sale, 1999). Using timetables and locating transfer points had been difficult for many people including visitors, first time users and those with sight and hearing impairment. Most information provided was not the ‘personalised’ type required by users planning for the next journey. Route maps and directional information in European studies were found to be difficult to digest (European Commission, 2004). Problems associated with comprehending, appreciating and utilising information in the more developed countries have also been discussed (Hine and Scott, 2000).

Most trips involving transfers from one public transport mode to another necessitated the multimodal information provision at interchanges. Impact studies of information have long been conducted. However, variation among users’ comprehension, utilisation and reaction towards information provided at these interchanges has yet to be clearly explained. For instance, consideration for service costs have outweighed the information provision when respondents were deciding between using two similar services (Cooper and Meiklejohn 2003)). Prominent studies also highlighted the differing responses and obedience levels among users, when encountered with at-terminal messages (Dogget et al., 2004). The external factors influencing the behaviours in these cases such as services familiarity and effects of previous experiences were, however, less explored.

Even more difficult was the process of seeking information about transfers or connecting mode and alternative routes en-route. This left them with feelings of insecurity, anxiety, frustration and other psychological effects (Wener et al., 2003). Providing this type of information in a timely manner and supplementing it with prescription of actions and alternative mode or route will lessen the burden of passengers. Most contemporary researches concentrated on pre-trip information.

Less was revealed regarding en-route or in-vehicle trip information gathering process. Hence, it is the intention of this study to bridge this gap in the literature, by providing greater understanding on the effects of (incidents related) information provision on commuters' behaviours.

Having to move mass number of people over short period of time, the public transport systems are highly susceptible to the current world scenarios of safety and security. Public transport authorities' and operators' need crowd and incident management and systematic emergency evacuation strategies in the events of rail service disruption. Disruptions can be due to incidents, special events and even terrorist attacks. In the events of incidents including delays, derailment, disruption, accidents and other events, real time and interactive information were seldom passed to passengers. In instances such as delays or service failure that required an alternative route to be planned, the public and transit users also preferred the 'human contact' to information displays (Tripp and Drea, 2002). Litman (2005) concluded that there needed to be more integrated information provisions regarding services disruptions due to incident detection and safety threat warnings, so as to manage stations crowding during crises. Marsden (1998) also supported that risk aversion and crowd management should be integrated with the information systems.

One prospect of multimodal information is the integration of all information for different modes sourced from a single portal. Great effort is required to access timely and integrated information. With the advancement in geographical positioning system (GPS) and geographical information system (GIS), information gathering, analyses, deliveries and retrieval can be made speedier, more accurate and more responsive to situational circumstances. Most public transport information was provided by single operators focusing on only a single mode. In order to ensure information integration, there needs to be a single body or authority to oversee the data collection, updating, processing and dissemination. In the absence of this single authority or executive body, it will be difficult to achieve the objective of providing integrated public transport information (Groenewald, 2003).In other words, information can be made more intelligent.

Deployment of Integrated Transport Information System (ITIS) which aim at maintaining the dwindling users, through the high quality information delivery, can therefore attract potential ones to public transport. Some studies revealed that many of today's journey made with environmentally unfriendly transport may have been triggered by decisions made based on imperfect information. Test and focus groups findings had it that if reliable information about competing or alternatives transport modes was made available, some of the decisions may have been swayed towards public transport (Banister and Stead, 2004). The existing and prospective users' confidence may be instilled and patronage levels may be sustained or even increased (Foote, 2005). Passengers have highlighted that they sought reliable, real time information, disseminated through dynamic media including variable message signs and text message via mobile phones.

At present, there exists no standardised format or framework for ITIS application adopted globally. Each region or nation has its own architectural system of development and deployment of integrated public transport information. It has been cautioned that many experiences from the more developed parts of the world may not necessarily suitable and applicable for adoption in developing countries (Wright and Fjellstrom, 2002) Uang and Hwang (2003) and Cheng and Firmin (2004) stressed the importance of developing cities to innovate and upgrade their systems according to local circumstances, climate and situations. In particular, considerations to the variation of experiences, exposure and complexity in acquiring and comprehending capacity of local subjects i.e. information users, should be given. So far, the bulk of studies have concentrated on systems found in developed nations. While these systems are more mature, sophisticated and received very positive responses from the public in general and public transport users specifically, the effects of younger and less advanced systems have not be widely and systematically tested.

Based on the review of these studies, several questions can be raised. First, what are the existing states of public transport information in developing cities? What are the features of more

advanced systems that have positively influenced public transport patronage in the more developed countries? How would a user response to the services disruption and connecting mode information in the event of public transport services delays? Finally, what are the prospects of integrated multimodal information provision at public transport interchanges?

This study attempts at describing the potentials that such provision would have on developing cities public transport interchanges. It helps transport agencies and investors alike to decide which system and what characteristics the system should have to induce public transport use and retain the existing riders. This study aims at exploring the relationships between personal characteristics and trip attributes and the decision made regarding continuing journey in a scenario where multimodal information is provided. The research also attempts to model the relationships, by evaluating the suitability of either multiple linear regressions or a multinomial logistic regression. Selection of the models is based on the literature review on modal split and modal switching behaviours.

3. METHODOLOGY

The reviews of relevant literature provide insight into three research questions. The first question is the identification of the existing scenarios facing public transport users with regard to multimodal information provision. Literature review also raised another question of the adequacy and quality of information provision at interchanges. This research looked into transfers between rail and feeder buses. Information regarding feeder buses which was provided on-board a commuter rail services assisted transferring passengers in times of delayed services has been evaluated. The effects and passengers' responses were recorded, analysed and presented.

Figure 1: The integrated public transport network of the case study, Kuala Lumpur.

A case study has been selected based on the locality and speed of development of its public transport system. Interchanges between rail and buses in *Klang Valley*, Malaysia was considered because of the recent overhaul or restructuring initiatives the Malaysian government towards integration of public transport system in the region. It involved a consolidation of buses and rail systems leading to partial integration of route networks, physical assets including rolling stocks, fare restructuring, human resource and financial management. The services levels are comparable to many developing nations' systems. One important feature was that the system was too susceptible to various imperfections, that services delays were persistent. In addition, the information system stayed at status quo since the 1990s because of several economic, establishment and physical issues. Hence, it was timely that an evaluation of pre-establishment of integrated information as well as an assessment of potential improvements of real time system be made. The results could later be compared, analysed and modal split projected, should such advanced system takes place.

Reviews of literature have also identified a number of appropriate and suitable methodologies for data collection. While each and every strategy has its own advantages and drawbacks, the selection may depend on the local circumstances, the existing state of information system and passengers' characteristics. The research adopted two types of data gathering strategies. First, observational surveys took inventory of the public transport information system that was in place. Second, on-board intercept surveys were undertaken to test the implication of hypothetical information provision. A set of survey questionnaire was designed and the surveys were executed using different dissemination media. Tests were conducted so as to assess the effects of information contents such as travel time changes and travel costs increases on mode selection.

Some 600 respondents answered the questionnaire. After data cleaning only 537 sets were considered valid for analysis. In the intercept surveys, a systematic sampling was adopted. The selected users were screened before information was provided under three different delay duration and three types of media. In total nine alternative scenarios and models can be developed. Simultaneously, users' perceptions of and travel decisions relating feeder bus services in the events of disruptions, were assessed. Messages regarding the availability of the supplementary service were provided to assist users; particularly for transfers purposes.

Data was gathered, coded and fed into the analysis or statistical packages. Three selected software were utilised to ensure that results were consistent. They are MsExcel, SPSS and NLOGIT (LIMDEP) programs. Each statistical package would employ similar dataset but have provided slightly varied approach to producing estimation results. The final aim was to model the responses to bus feeder services. Based on reviews of the existing works on modal split and mode switching behaviour, two types of models have been considered. Multiple linear regression and multinomial logistic regression have been tested. Different levels of statistical significance results will be presented for purposes of estimating, calibrating and validating the models.

4. RESULTS OF THE FIELD STUDIES

The major findings regarding mode selections are reported and discussed. Male users constituted some 52 percent of the total respondents. The average household monthly income was less than RM2000 (USD555) and the average age 21-30 years old. About 55 percent used the services for commuting or educational trip purposes. Approximately five percent were first time users. Most of the respondents were familiar with the existing system which comprised mostly static or non-changeable information. Basically, most of them have not encountered the dynamic (changeable) information regarding delays in the alternative scenarios. The hypothetical information in the survey was to emulate those provided in the more advanced public transport systems worldwide. These included pre-recorded audio announcement of delay reason, duration and estimated time for services to resume as normal. They also contained information on alternative routes and supplementary vehicles. The information was also provided through multiple line scrolling variable message liquidized electronic diodes (LED) displays and graphical presentation in a movie form.

In general, the respondents also welcome such proposed initiatives of providing delay information via real time audio, variable message signs and graphical media. However, mixed responses were exhibited by users surveyed with regards to the accuracy, reliability and usefulness of the hypothetical information provided. These responses have been translated into mode choice decision making process, and this study intends to discuss the variations in this travel behaviour.

The test results of mode selection during delayed services were analysed so as to answer the research question of how information effects decisions and how travel time and costs changes influences perception towards the information provided. In the tests measuring the responses towards a hypothetical feeder bus service, passengers were found not to be highly impacted by changes in fare structure and invariability in total travel time. According to statistical tests and modelling attempts, this projected number of passengers selecting feeder as an alternative mode during delayed services were only small. These occurred for scenarios of 30, 45 and 60 minutes delays and also when the information was upgraded from audio to text and to visual forms.

The study subscribes to the simplest discrete choice model namely multinomial logit model. The theory underlying the model development was that all decisions regarding the mode choice was based on the disutility or generalized costs associated with the set of alternative mode choices. The equation representing the generalized cost or random utility maximisation is:

$$C_{ij} = a + \beta_1 t^u_{ij} + \beta_2 t^t_{ij} + \beta_3 t^p_{ij} + \beta_4 t^n_{ij} + \delta \qquad (1)$$

where:

C_{ij} = the generalised cost of travelling from zone *i* to zone *j* using a particular mode
t^u_{ij} = users socio-economic characteristics
t^t_{ij} = users trip characteristics
t^p_{ij} = public transport services characteristics
t^n_{ij} = other independent factors such as delay duration
δ = parameter representing errors
a = mode specific constant
β = coefficient

Further, the multinomial logit model can be represented by an exponential relationship. The study concentrates on the proportion of respondents selecting feeder buses as an alternative mode. Therefore, the proportion of trips by feeder buses is given by:

$$P^1_{ij} = \frac{T^1_{ij}}{T_{ij}} = \frac{e^{\beta c1ij}}{e^{\beta c1ij} + e^{\beta c2ij}} \quad \text{or} \quad P^1_{ij} = \frac{e^{\beta c1ij}}{\sum e^{\beta cmij}} \qquad (2)$$

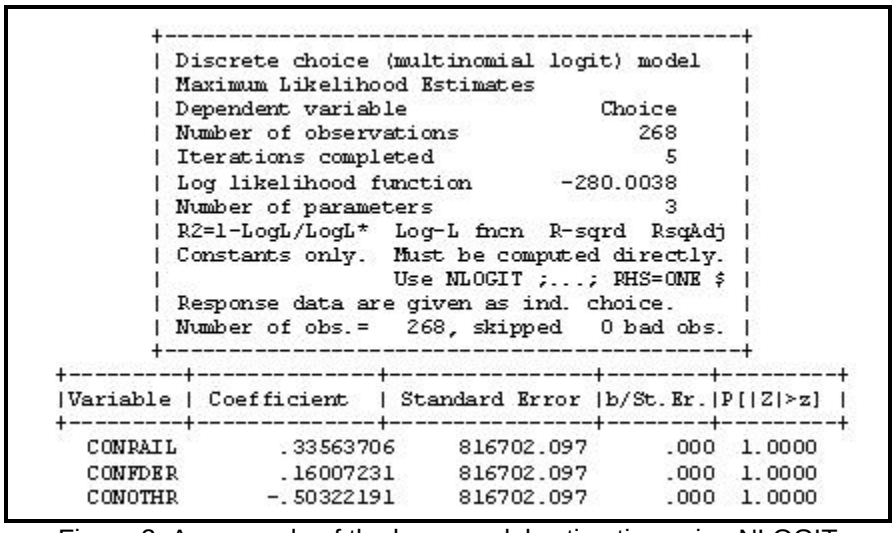
where:

T^1_{ij} = the number of trips made from zone *i* to zone *j* using feeder buses (mode 1)

T_{ij} = the total trips made from zone *i* to zone *j*

Multinomial logit regression is applied when the categorical dependent variable that has more than two categories or multiple modes, say an inclusion of feeder bus services as another mode choice. In the analysis, a reference group has been chosen, namely the selection of (waiting for) rail or other public transport mode. The equation for such a model can be simplified as:

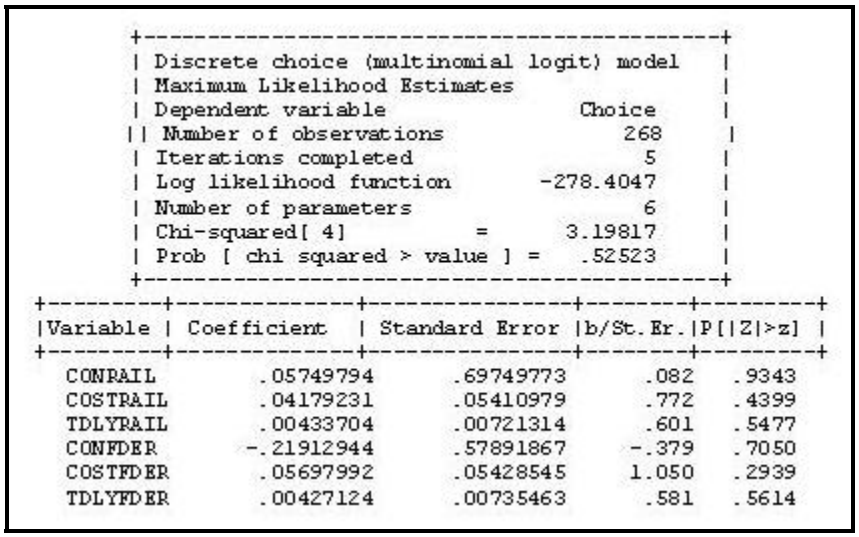
$$P^1_{ij} = \frac{1}{1 + e^{\beta c1ij} + e^{\beta cmij}} \qquad (3)$$



```
+-------------------------------------------+
| Discrete choice (multinomial logit) model |
| Maximum Likelihood Estimates              |
| Dependent variable              Choice    |
| Number of observations             268    |
| Iterations completed                 5    |
| Log likelihood function       -280.0038   |
| Number of parameters                 3    |
| R2=1-LogL/LogL*  Log-L fncn  R-sqrd  RsqAdj |
| Constants only.  Must be computed directly. |
|                  Use NLOGIT ;...; RHS=ONE $ |
| Response data are given as ind. choice.   |
| Number of obs.=   268, skipped   0 bad obs. |
+-------------------------------------------+
+---------+-------------+----------------+--------+---------+
|Variable | Coefficient | Standard Error |b/St.Er.|P[|Z|>z] |
+---------+-------------+----------------+--------+---------+
  CONRAIL       .33563706     816702.097      .000  1.0000
  CONFDER       .16007231     816702.097      .000  1.0000
  CONOTHR      -.50322191     816702.097      .000  1.0000
```

Figure 2: An example of the base model estimation using NLOGIT

Firstly, the base model is developed. The model for scenario contained a mode specific constant. The Figure 2 above provides the log likelihood function at the intercept and the number of parameters entered. It also indicates the market share of each mode for the base model.



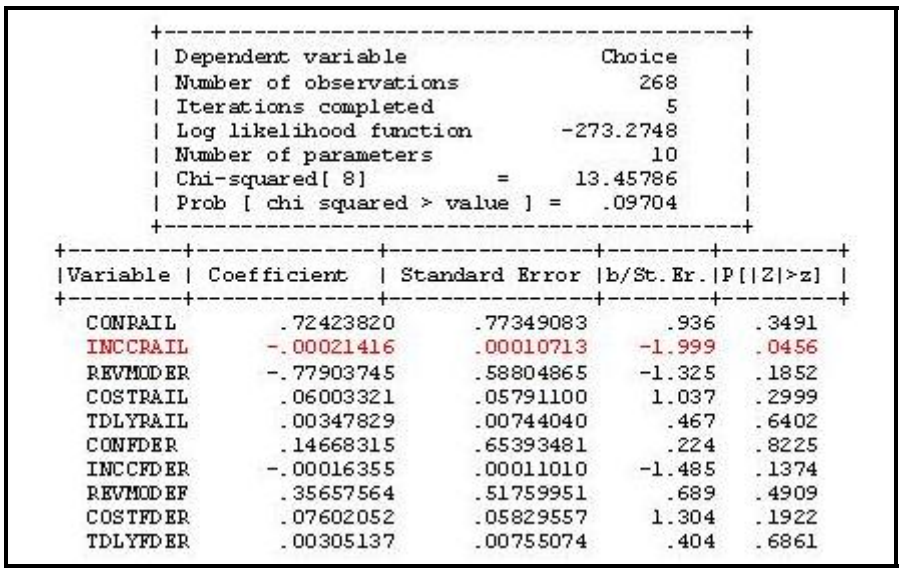
```
+-------------------------------------------+
| Discrete choice (multinomial logit) model |
| Maximum Likelihood Estimates              |
| Dependent variable              Choice    |
|| Number of observations             268   |
| Iterations completed                 5    |
| Log likelihood function       -278.4047   |
| Number of parameters                 6    |
| Chi-squared[ 4]          =      3.19817   |
| Prob [ chi squared > value ] =    .52523   |
+-------------------------------------------+
+---------+-------------+----------------+--------+---------+
|Variable | Coefficient | Standard Error |b/St.Er.|P[|Z|>z] |
+---------+-------------+----------------+--------+---------+
  CONRAIL       .05749794      .69749773      .082   .9343
  COSTRAIL      .04179231      .05410979      .772   .4399
  TDLYRAIL      .00433704      .00721314      .601   .5477
  CONFDER      -.21912944      .57891867     -.379   .7050
  COSTFDER      .05697992      .05428545     1.050   .2939
  TDLYFDER      .00427124      .00735463      .581   .5614
```

Figure 3: An example of alternative estimation using NLOGIT

Figure 3 below shows estimation results for an alternative model. The scenario involved information being provided through visual media under sixty minutes delay scenario. It can be seen that classical parameters of costs and travel time associated with rail and feeder choices were not significant (*t-statistics* < *1.96*) in determining the mode switching behaviour. These variables hence could not be considered in the model calibration.

Similar steps of calibration were conducted for various situations of delay duration and media types. Estimation of parameters could not be successfully achieved due to the incapability of producing cost and travel time as significant parameters for the models. In addition, all attempts resulted in low log-likelihood values or r^2. Another estimation run was carried out to include one socio-demographic and one trip characteristic. In Figure 4, only the income parameter was statistically significant (*t-statistics: -1.99*) in determining the model equation. The negative coefficient value for rail users meant that as income increased the attractiveness of rail relative to

other mode decreases. In two situations, parameters such as income and revealed mode appeared to be significantly influencing the mode choices.



Dependent variable	Choice
Number of observations	268
Iterations completed	5
Log likelihood function	-273.2748
Number of parameters	10
Chi-squared[8] =	13.45786
Prob [chi squared > value] =	.09704

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]
CONRAIL	.72423820	.77349083	.936	.3491
INCCRAIL	-.00021416	.00010713	-1.999	.0456
REVMODER	-.77903745	.58804865	-1.325	.1852
COSTRAIL	.06003321	.05791100	1.037	.2999
TDLYRAIL	.00347829	.00744040	.467	.6402
CONFDER	.14668315	.65393481	.224	.8225
INCCFDER	-.00016355	.00011010	-1.485	.1374
REVMODEF	.35657564	.51759951	.689	.4909
COSTFDER	.07602052	.05829557	1.304	.1922
TDLYFDER	.00305137	.00755074	.404	.6861

Figure 4: An example of another alternative model estimation using NLOGIT

Table 1 provides the results of multiple linear regression and multinomial logit model estimation attempts for different responses to intelligent public transport information provision. The results for nine situations of media type with staged delay durations were presented.

It can be seen that none of the situation has successfully produced a model with both conventional variables as estimating factors. In other words, travel time and travel costs were found to be insignificant in determining the behavioural choices, at 95% confidence interval.

The r^2 values were calculated for the multiple linear regressions. For the multinomial logit regression model, the ratio of log likelihood between the base model and the attempted models were calculated to measure the degree of relationships. These values were too low for the consideration of model fitting.

Additionally, coefficient signs and magnitude were evaluated against findings of existing studies. The signs were incorrect in some cases, where time and costs were identified as positive rather than negative. This could be attributable to the relatively low trade-off or opportunity cost values put by these sample respondents. Passengers surveyed were in general of lower income category and more than proportionately were traveling off-peak with non-commuting purposes. These factors could have influenced the perception of time and costs among the passengers.

Moreover, passengers have already had some levels of familiarity with the services unreliability. Delays were persistent in the existing system. At time of writing, there were three improvements strategies carried out by the public transport operator as a response to the preliminary findings presented. One was the enhancement of audio information or public announcement of delay details. Another was the change in the headway or service frequency from fifteen minutes interval to twenty minutes in an hour, regardless of peak or off-peak period. Finally, there was a new non-stop shuttle services introduced for the selected routes during morning and afternoon peak hours.

However, none of the hypothetical situations presented in the questionnaire reflected these changes. Therefore, the relatively low time and cost values recorded for the dataset. Instead, the questionnaire has captured some unobserved factors that were found to be impacting the mode choice decision to a certain degree. These were the non-confidence in information, bad experiences with previous history of schedule in-adherence and uninformed delays.

Table 1: Summary of cost and time variable estimation results by selected hypothetical situations.

Analysis Packages / Estimation Results		LIMDEP	
AUDIO30	ρ^2	Coefficient β	*t*-statistic
costfder	0.001	-.14046262	-.502
tdlyfder		.01374737	.778
AUDIO45			
costfder	0.004	.00691067	.033
tdlyfder		-.00083157	-.064
TEXT30			
costfder	0.004	-.08018888	-.143
tdlyfder		.00635953	.176
VISUAL60			
costfder	0.014	.00790297	.028
tdlyfder		.00786912	.448

Calibration were undertaken and validation despite the low r^2 values. Two parameters are considered and their beta values are varied to be compared with the remaining half of the dataset. The models developed illustrate that an income increase, the proportion of those selecting feeder buses also increase. In contrast, if the previous experience of delayed trips has resulted in modal switch, there would be an increase in the proportion of passengers who would switch to feeder buses.

During the on-board intercept surveys, a number of passengers have also experienced real life delays on three different occasions. In the surveys, passengers indicated that it was difficult to measure the accuracy and reliability of such information. Furthermore, the non-existence of reliable bus feeder services along the surveyed routes did not increase users' confidence in the information provided. The mode switching behaviour was measured for a prior to the trip i.e. the previously delayed trips and for a hypothetical 30, 45 and 60 minutes delayed trips.

The purpose providing the information relating to costs and travel time was to emulate previous studies that have employed these two important parameters in the estimation, calibration and validation exercises. It seemed that these two variables have insignificant roles within the decision making process of passengers surveyed. While travel time and costs proved to be highly relevant input in many mode selection decisions, the case study has uniquely showed that this was not necessarily true for all systems. In short, in a developing public transport services with an information system still at its infancy and disintegrated fare system, information may not be very influential as it was envisaged to be. Additionally, time and costs did not significantly impact the travel decisions of many public transport riders, even during services disruption.

Calibration exercises involved splitting the sample into two subgroups. The first dataset was used for parameter estimation. Since there was no existing model being adopted and evaluated, the second half of the dataset was employed in the validation process. Random number generated in the MsExcel program. The aim of the research was to identify whether a simple multinomial model can be employed to represent the relationship exhibited by the samples dependent and independent variables. In this

The estimation process was proven to be a challenging one. Half of the dataset was selected using random numbers for calibration purpose. Calibration concerns with how to determine empirical formula or function, f (x) for a given for a given types of variables (X,Y) for a given type of samples. Constant is to represent some features of local circumstances. Local circumstances are such as the services attractiveness, microclimate and culture. This also called the alternative mode specific constant. The constant values are calibrated. Increment of tenfold and more could be adopted to deal with errors in measurement, survey design and survey conduct.

Models were also calibrated using different beta or coefficient values of two parameters. These are income category and revealed behavioural change in previous delayed trips. The probability of respondents selecting feeder was calibrated against these parameters. The slope and nature

of the probability distributions are also evaluated. The remainder of the dataset was utilised for validation purposes. This involved comparing the estimated and calibrated models of passenger behaviour. It is reiterated that only bus feeder mode choice was focused in this study.

Figure 5 depicts the stated preference results of one situation of delay duration with specific media type. It can be seen that the percentage of respondents selecting bus feeder mode increased with income level up to the threshold of approximately RM3000. The proportion of feeder mode selected decreased beyond this level only to increase again until another peak was reached at RM6000. The bimodal distribution can be attributed to the inclusion of some overseas visitor who may have converted their income into Malaysian Ringgit.

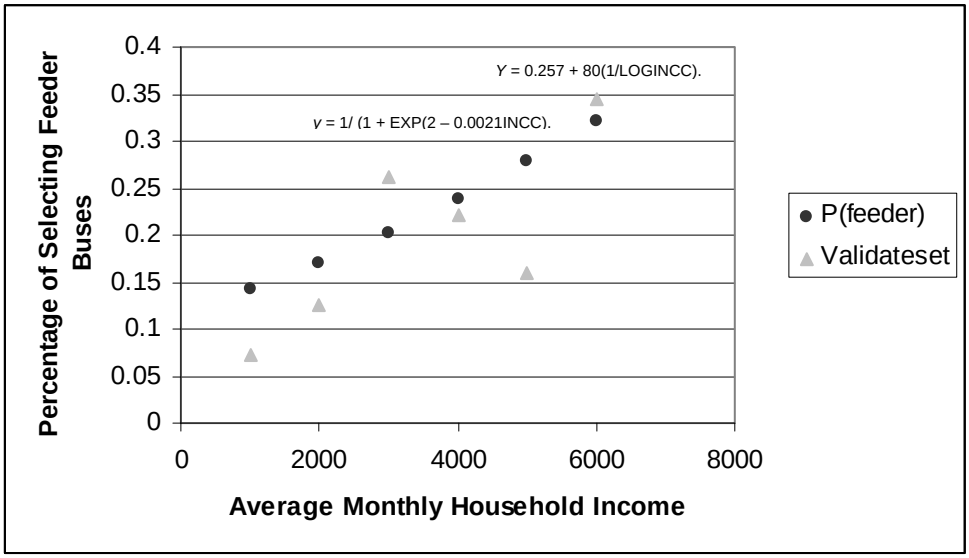


Figure 5: An example of the relationship between feeder mode selected and income levels.

Validation was carried out by performing regression analysis on the remaining half of the dataset. The simple linear regression representing the relationship between income and feeder mode choice for the validation set of split data is:

$$Probability(feeder) = 0.257 + 80(1/LOGINCC).\ (r^2=0.6)$$

Due to some local and unique circumstances of case study's public transport services the modelling calibration and validation could not be completed successfully. Despite the low r^2 values, income levels and revealed preference of mode switching were, nevertheless, considered for the model estimation. The former was a continuous data but the latter was a dummy variable. Hence, calibration and validation were only carried out for the income parameter; with other parameters e.g. revealed mode and age category held constant. The result showed that by increasing the constant and the coefficient values, some degrees of validation can be achieved.

In real life, the respondents have exhibited that factors cost and time were secondary consideration in mode choice decision making. Connectivity, feeder non-existence as well as confidence in information reliability, validity and accuracy have been indicated as the unobserved variables that could have played some roles in the process. Currently, there is no integration between feeder bus and suburban rail fare systems.

The vast variability of bus travel time compounded by congestion, heavy rain, climate, micro and differing cultures and values could have also influenced mode selection. Additionally, survey conducts and other local factors could not be controlled like some variables in more strict experiments or laboratory tests. Only a small proportion of users have actually encountered with

the VMS type of information and lesser with the dynamic media content of information. Many users surveyed have had different levels of experiences with the same mode and the proposed alternative modes. While rational choices could be made, passengers did not necessarily select the best mode. Rather, choices were made for a mode which users have more knowledge about.

The study has dealt with a real-life situation, where questionnaire was design to feed the actual travel experience. Their responses were more unpredictable than one that could be anticipated within a controlled environment such as in laboratory experiments. These responses were also random to some degree because respondents could not contemplate more freely without time restriction than they would otherwise in household or office-work place survey environment. It was also clear that habit, intention and execution of mode choice travel decision were interrelated. Indeed, revealed mode variable was found to be significantly influencing choices. There existed a learning time gap as passengers familiarized themselves with the dynamic information media and contents. It can also be argued that the siting of information media on-board the train might have some impacts on decision making process. These media might have not been ergonomically designed for all passengers attempting the questionnaire.

5. DISCUSSION AND CONCLUSIONS

The paper has identified an absence of integrated information within a public transport system in the case study. The study has explored some prospects for the implementation of multimodal information system. Across the world, multimodal information provision at interchanges has been on the increasing trend. One positive outcome of the integrated information was that it can be highly regarded by users requiring transfers between different modes of public transport. Another area benefiting from the provision was the crowd or incident management. Passengers needing directions and alternatives in times of delayed services have found it somewhat beneficial. Transport service operators would find it useful in managing the crowd and systematically evacuating or transferring passengers to supplementary vehicles. Multimodal information also has a prospect in retaining the existing public transport patrons.
Other studies have largely found that information provision might be useful in many public transport networks. However, in this research, the responses have been varied, or even slightly different from those concluded by the bulk of existing literature. In one area, modal split could not be easily determined by the multinomial logit model because passengers seemed to have made decisions out of the norms, namely that generalised costs and time associated with alternative modes were not the most influential factors in trip decision making processes.

The modal split changes have been presented and potentials of integrating rail-bus information outlined. Modelling the switching behaviours has been undertaken utilising three statistical software packages. An attempt to calibrate the proportion of prospective passengers selecting feeder buses based on parameter estimates derived from the model developed was made, albeit with limited capability. Validation of the model against the observed behaviours was also attempted. Factors such as personal traits, trip characteristics and previous decisional influences on the current selection have been discussed in brief.

The findings were inconsistent with the existing literature, in at least three ways. First, travel costs and time were not the important factors in determining sub-modal split during an event of services disruption. Second, improving the multimodal information delivery method from audio to text may not necessarily increase the comprehension level and positive responses as can anticipated in many public transport systems elsewhere. However, upgrading the information media from textual to visual has, to a certain extent, improved the general responses towards feeder buses, i.e. retaining of public transport patronage Third, the inconsistency of information appreciation could have been distorted by biases introduced in the survey design. The hypothetical information was not provided randomly. In other words, the scenarios were presented in a pattern easily identified by users for the purpose of minimizing the cognitive effort of completing the questionnaire. This pattern might have been perceived by users as too predictive, especially after

the first three scenarios were tested. Therefore, it could reduce the attentiveness towards the remainder of the scenario evaluations. Hence, another research into the area may be needed.

This study has dealt with three research questions regarding the impacts of integrating road- and rail-based public transport information systems. One question arose, namely when decision making properties were being investigated. A possible reason for the non-significance of costs and time could be the proportion of captive riders. In other words, there was a high proportion of commuters and students within the sample who depended on this low cost travel mode. Income level has been found to be statistically significant in three of the nine sub-models. Additionally, "real-life delayed trips" mode selection reacted very insensitively to the provided information, but more responsively towards personal experiences, knowledge and familiarity with the existing public transport services level. Viewpoints of passengers surveyed have also qualitatively recoded. Most have indicated that the current system was not adequately provided to instill confidence and trust in the information provided, regardless of the means of dissemination and delay duration. Factors such as personal traits, trip characteristics and previous decisional influences on the current selection are discussed in brief. It can be seen from the results that only two parameters can be estimated. Income and revealed preference for mode switch in the previously delayed trips. Income is related to many other socio-economic factors and costs-related decisions such as travel time, travel costs and interchanging efforts.

People learn from experience of using public transport. If they were persistently delayed, the services would have very low reliability because average travel time was highly variable. They would not have high confidence in the system, not to mention the information provision. Even if information was provided to assist further travel decisions, it would not help in situations where users have already lost trust in the services. It is, therefore, a pre-requisite of intelligent transport information to have a very good, reliable and a necessity for the existing transport networks to maintain very low travel time variability. Otherwise, interchanges are the best places for multimodal information provision. Information on-board public transport vehicles also have great potentials. It can assist the respective users to decide when, where and how to transfer to connecting modes. So, what explains the low responses or lukewarm reactions to the information provided in the case study? This remains a question unanswered by the study and opens up to new ground for future research. An extended research is possible to look at the unique local circumstances and factors such as micro-climate, culture and intimidation of captive choices.

It was somehow strange that public transport users surveyed did not consider the information useful, although several form and contents have been provided for decision making purposes. For the survival of the public transport, instilling the confidence of users on the connectivity of services and information accuracy and reliability should have a more important role than just increasing efficiency of information media and frequency.

REFERENCES

1. Wright and Fjellstrom. Module 3a Mass Transit Options. Sustainable Transport: A sourcebook for policy-makers in developing cities. Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ) GmBH. Eschborn. 2002.

3. Keretapi Tanah Melayu Berhad KTMB. KTM Komuter: Malaysia's first electrical rail. Kuala Lumpur. 1996.

4. Sale, R. The MIMIC approach. Final Conference of PIRATE, MIMIC & GUIDE: making interchange successful. Amsterdam. 1999.

5. European Commission. Report 1: analysis of the key issues for passenger modality. Dortmund. 2004.

6. Hine, J and Scott, J. Seamless, accessible travel: users' view of the public transport journey and interchange. Transport Policy. Vol.7. pp. 217-226. 2000.

7. Cooper, B. and Meiklejohn, D. A new approach for travel behaviour change in universities. 26th Australasian Transport Research Forum. Wellington. 2003.

8. (Dogget, M., Douglas, N and McGregor, G. The spatial profile of rail trips within the Sydney CBD. 27th Australasian Transport Research Forum. Adelaide. 2004)

9. (Wener, R., Evans, G., Phillips, D. and Nadler, N. Running for the 7.45: the effects of public transit imrpvement on commuter stress. Transportation. Vol.30(2). pp.203-220. 2003.

10. Tripp, C. and Drea, J. Selecting and promoting service encounter elements in passenger rail transportation. Journal of Services Marketing. Vol.16(5). pp.432-442. 2002.

11. Litman, T. Terrorism, transit and public safety: evaluating the risks. Journal of Public Transportation. Vol.8(4). pp. 33-43. 2005.

12. Marsden, A. Training railway operating staff to understand and manage passenger and crowd behaviour. Industrial and Commercial Training. Vol.30(5). pp.171-175. 1998.

13. Groenewald, H. Establishment of transport authorities in local sphere of government in South Africa: unfolding of the process. Transport Policy. Vol.10(1). pp.1-15. 2003.

14. Banister, D. and Stead, D. Impact of ICT on transport. Transport Reviews. Vol.24(5). pp.611-632. 2004.

15. Foote, P. Making buses better in Chicago: strategic implementation of customer-derived performance measures from 1995-2001. Transportation Research Record. Vol.1884. pp.18-26. 2005.

16. Uang, S.T. and Hwang, S.L. Effects on driving behaviour of congestion information and of scale of in-vehicle navigation systems. Transportation Research C. Vol.11. pp.423-438. 2003.

17. Cheng, J.J. and Firmin,P. Perception of VMS effectiveness: A British and Canadian perspective. 12th IEE International Conference on Road Transport Information and Control. pp.175-185. 2004.

The 13th Conference of the Road Engineering Association of Asia and Australasia (REAAA): 'Future Road - Safer, Greener & Smarter'
Songdo Convensia, Incheon Metropolitan City, Korea.
September 23~26, 2009.

Abstract submission

Author: Syahriah Bachok, Wen Long Yue and Rocco Zito
Transport Systems Centre, University of South Australia, Adelaide, Australia.

INTEGRATING MULTIMODAL TRAVEL INFORMATION AT MAJOR TRANSPORT INTERCHANGES: THE PROSPECTIVE OF INTELLIGENT PUBLIC TRANSPORT INFORMATION SYSTEMS.

ABSTRACT

Inducing car-drivers to switch mode to public proved to be one of the greatest challenges faced by many transport planners and traffic engineers. Retaining public transport users also seemed to be an issue, especially within an industry that has dwindling patronage trends. This paper presents some findings of an evaluation of a hypothetical rail-bus information integration to promote the retaining of existing users of a public transport service. In the events of service disruptions, users' perceptions of and travel decisions relating feeder bus services were assessed. Messages regarding the availability of the supplementary service were provided to assist users; particularly for interchanges or transfers purposes. The major findings regarding mode and route selections are reported and discussed.

The modal split changes are highlighted and potentials of integrating rail-bus information are outlined. Modelling the switching behaviours has been undertaken utilising a number of statistical software packages. The proportion of prospective passengers selecting feeder buses are calibrated based on parameter estimates derived from the model developed, and further validated against the observed behaviours. Factors such as personal traits, trip characteristics and previous decisional influences on the current selection are discussed in brief.

Keywords: intelligent transport systems, integrated public transport, interchanges, information, modelling.